January 8, 1891.

Lieut.-General STRACHEY, R.E., Vice-President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read :—

I. "On the Minute Structure of the Muscle-columns or Sarcostyles which form the Wing Muscles of Insects. Preliminary Note." By E. A. SCHÄFER, F.R.S. Received December 15, 1890.

[Publication deferred.]

II. "On the Minute Structure of Striped Muscle, with Special Reference to a New Method of Investigation, by means of 'Impressions' stamped in Collodion." By JOHN BERRY HAYCRAFT. M.D., D.Sc., F.R.S.E. Communicated by Dr. KLEIN, F.R.S. (From the Physiological Laboratory, Univ. Edin.) Received January 2, 1891.

[Publication deferred.]

III. "On the Reflection and Refraction of Light at the Surface of a Magnetised Medium." By A. B. BASSET, M.A., F.R.S. Received December 17, 1890.

(Abstract.)

The object of the present paper is to endeavour to ascertain how far the electromagnetic theory of light, as at present developed, is capable of giving a theoretical explanation of Dr. Kerr's experiments* on the effect of magnetism on light.

In the first series of experiments, polarised light was reflected from the polished pole of an electromagnet, so that the lines of magnetic force were perpendicular to the reflecting surface; and in the second

* 'Phil. Mag.,' May, 1877, and March, 1878.

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series, the light was reflected from a polished plate of soft iron laid upon the poles of a horseshoe electromagnet, so that the lines of magnetic force were parallel to the reflecting surface. In both series of experiments, it was found that, when the circuit was closed, so that the reflector became magnetised, the reflected light exhibited certain peculiarities, which disappeared when the current was off. It was also found that the effects of magnetisation were, in most cases, reversed when the direction of the magnetising current was reversed; that is to say, if the intensity of the reflected light was strengthened by a right-handed current, it was weakened by a left-handed one.

In these experiments, a metallic reflector was employed, and consequently the results were complicated by the influence of metallic reflection; it therefore seems hopeless to attempt to give a complete theoretical explanation of these experiments until a satisfactory electromagnetic theory of metallic reflection has been discovered; and this, I believe, has not yet been done.

There are, however, several non-metallic substances (such as strong solutions of certain chemical compounds of iron), which are capable, when magnetised, of producing an effect upon light; and the theoretical explanation of the magnetic action of such substances upon light is accordingly free from the difficulties surrounding metallic reflection. I have accordingly, in the present paper, attempted to develop a theory which is applicable to such media.

The theory, which is due to Professor Rowland, is founded upon the following considerations:—

It was proved by Hall* that, when a current passes through a conductor which is placed in a strong magnetic field, an electromotive force is produced, whose intensity is proportional to the product of the current and the magnetic force, and whose direction is at right angles to the plane containing the current and the magnetic force. Professor Rowland† has assumed that this result holds good in a dielectric which is under the action of a strong magnetic force; accordingly the general equations of electromotive force become

$$\mathrm{P} = -\frac{d\mathrm{F}}{dt} - \mathrm{C}\,(\gamma\dot{g} - \beta\dot{h}) - \frac{d\psi}{dx} \ldots\ldots\ldots\ldots\ldots (1),$$

where α, β, γ are the components of the external magnetic force, and C is a constant which depends upon the physical constitution of the medium.

Writing $p_1 = \mathrm{C}\alpha$, &c., it follows that, if the medium is isotropic, the equations of electric displacement are of the form

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* 'Phil. Mag.,' March, 1880.

† *Ibid.*, April, 1881.

$$\frac{d^2f}{dt^2}=\frac{1}{\mu\mathrm{K}}\nabla^2 f+\frac{1}{4\pi\mu}\left(p_1\frac{d}{dx}+p_2\frac{d}{dy}+p_3\frac{d}{dz}\right)\left(\frac{d\dot{g}}{dz}-\frac{d\dot{h}}{dy}\right)\ldots\ldots (2).$$

The boundary conditions are : continuity of magnetic induction and electric displacement perpendicular to the reflecting surface, the latter of which is equivalent to continuity of magnetic force perpendicular to the plane of incidence; continuity of magnetic force along the line of intersection of the plane of incidence with the reflecting surface; continuity of the rate at which energy flows across the reflecting surface. Now the refracted light consists of two waves, circularly polarised in opposite directions, and the reflected light is elliptically polarised; we have, therefore, four equations to determine the amplitudes of the two refracted waves, and the amplitudes of the two components of the reflected wave.

The results of the paper agree with Dr. Kerr's experiments in the following particulars :—

(i.) The reflected light is elliptically polarised.

(ii.) When the magnetisation is parallel to the reflecting surface, no effect is produced when the incidence is normal, or when the plane of incidence is perpendicular to the direction of magnetisation.

(iii.) When the plane of incidence is parallel to the direction of magnetisation, and the light is polarised *in* the plane of incidence, the magnetic term increases from grazing incidence to a maximum value, and then decreases to normal incidence.

The principal point of disagreement is, that in all cases the intensity of the reflected light is unchanged when the direction of the magnetising current is reversed.

I do not think that the results of the theory can be considered altogether unsatisfactory, since they certainly explain some of Dr. Kerr's experimental results; and I am disposed to think that the disagreement is due to the disturbing influence of metallic reflection. At the same time, the question is one which can only be decided by experiment, and it is therefore most desirable that experiments on magnetised solutions should be made.

IV. "Further Contributions to the Metallurgy of Bismuth." By EDWARD MATTHEY, F.S.A., F.C.S., Assoc. Roy. Sch. Mines. Communicated by Sir G. G. STOKES, Bart., F.R.S. Received December 22, 1890.

In October, 1887, I read a paper before the Royal Society* upon a new method which I incidentally discovered while working with a view to separate copper from bismuth, by fusion with bismuth sulphide.

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* 'Roy. Soc. Proc.,' vol. 43, p. 172.